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War Memorandum No. 11

THE CONTROL OF CROSS INFECTION IN HOSPITALS

(Memorandum prepared for the Committee on Preventive Medicine of the Medical Research Council by the Sub-Committee on Cross Infection in Hospital Wards)

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The late Professor Hedley D. Wright, as a member of the Sub-Committee, gave much valuable assistance in the preparation of this Memorandum.

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THE CONTROL OF CROSS INFECTION IN HOSPITALS

CONTENTS

PAGE

INTRODUCTION by Sir W. Wilson Jameson, K.C.B., M.D., F.R.C.P., D.P.H. 4

I.—PREVALENCE AND CONSEQUENCES OF CROSS INFECTION 5
1. Respiratory infection .. 5
2. Gastro-intestinal infection .. 6
3. Wound infection 6
4. Skin and mucous membrane infection 7

II.—SOURCES AND MODES OF INFECTION 7
A. Contact and mediate infection.
(*a*) *by persons* 7
(*b*) *by clothes* 7
(*c*) *by ward articles* 8
(*d*) *by food* 9
(*e*) *by insects* 9
B. Droplet-borne infection .. 9
C. Dust-borne infection .. 9

III.—THE PREVENTION AND CONTROL OF CROSS INFECTION .. 11
1. General administrative procedures 11
2. Admitting procedure .. 12
3. Isolation nursing .. 12
4. Immunisation of patients .. 12
5. Chemo-prophylaxis 13
6. Visiting in children's wards, maternity units and infectious diseases hospitals .. 13
7. Staff health and hygiene .. 13
(*a*) *Immunisation* 13
(*b*) *Medical examination, etc.* 14
(*c*) *Sickness* 14
(*d*) *Personal hygiene* 14
8. Labour-saving methods .. 14
9. Control of contact and mediate infection 15
(*a*) *Hand-washing* 15
(*b*) *Laundry* 15
(*c*) *Food* 16
(*d*) *Breast-feeding* 16
(*e*) *Cow's milk* 16
(*f*) *Preparation of bottle-feeds* 16
(*g*) *Milk kitchens* 16
(*h*) *Temperature-taking* .. 17
(*i*) *Playthings* 17
(*j*) *Surgical dressings* .. 17

PAGE

III.—THE PREVENTION AND CONTROL OF CROSS INFECTION—*contd.*
10. Control of droplet-borne infection 17
(*a*) *Ventilation* 17
(*b*) *Bed-spacing* 17
(*c*) *Face-masks* 17
(*d*) *Aerial disinfection* .. 18
11. Control of dust-borne infection 18
(*a*) *Bedclothes* 18
(*b*) *Floors* 18
(*c*) *Cleaning duties* 18
(*d*) *Protection from dust* .. 19

IV.—PROCEDURE FOLLOWING THE OCCURRENCE OF INFECTION IN A WARD 19
1. General measures 19
2. Additional special precautions 19
A. Haemolytic streptococcus infection 19
B. Diphtheria 20
C. Measles 20
D. Pertussis (Whooping Cough) .. 21
E. Gastro-enteritis of infants .. 21
F. Epidemic diarrhœa of the newborn 22
G. Dysentery 22
H. Paratyphoid, typhoid and food-poisoning 22
I. Chicken-pox, herpes zoster, rubella or mumps 22
J. Vulvo-vaginitis 23

Appendix A. Disinfection and sterilisation 23
1. *Disinfectants* 23
2. *Concurrent disinfection* 24
3. *Terminal disinfection* 26

Appendix B. Rules for isolation nursing in cell or open ward 26

Appendix C. Special precautions for maternity units 27

Appendix D. Rules for a ward dressing team 29

Appendix E. Application of spindle oil to floors 30

Appendix F. Course of practical bacteriology for nurses .. 30

Appendix G. References 32

INTRODUCTION

by

SIR W. WILSON JAMESON, K.C.B., M.D., F.R.C.P., D.P.H.
(Chief Medical Officer, Ministry of Health; Chairman of the M.R.C. Committee on Preventive Medicine)

The Sub-Committee on Cross Infection in Hospital Wards, appointed by the Preventive Medicine Committee of the Medical Research Council in 1939, made the preparation of a special report on the control of cross infection one of its first objectives. It found, however, that many of the proposed recommendations, particularly with regard to the structure of hospitals, were impracticable under war conditions. This War Memorandum has accordingly been prepared instead, in the hope that, in face of all the present difficulties, some attempt will be made to reduce the incidence of infections contracted unnecessarily in hospital.

Cross infection is most apparent and most dangerous amongst infants and juvenile patients, and the memorandum deals mainly with children's wards in general hospitals and hospitals for infectious diseases. But although adults have acquired relative immunity to the common infections of childhood, they are none the less vulnerable to certain pyogenic and other micro-organisms, and many of the streptococcal infections of wounds, burns and the placental site are contracted in hospital. The principles of the spread of cross infections, and the measures advocated for their control, therefore apply to all hospital wards. The risks are greatest in wards for the treatment of infectious diseases and of ear, nose and throat conditions, where sources of cross infection are inevitably present, but precautions must be taken in every ward, not excepting those containing " clean " (e.g. maternity and non-infected surgical) cases.

Factors of obvious importance are proper building and sufficient equipment, but alterations and improvements in these respects may in many instances have to wait until the end of the war. Given good ventilation and bed spacing, the control of cross infection turns largely on three things: adequate isolation accommodation, adequate sterilisation and disinfection equipment, and sufficient trained staff to maintain a meticulously careful technique. Serious deficiencies in one or more of these essentials exist in most hospitals, but the Sub-Committee believes that, even today, conditions could be improved. For example, the best use should be made of all trained staff, and they should not waste on unskilled tasks effort better spent on acquiring and practising a good technique. Bad tools may be an excuse for bad work and much valuable time is lost on account of insufficient and inefficient equipment. Deficiencies should be recognised and, when replacements cannot be procured, necessity may beget invention. Much can be done by improvisation, with the help of hospital engineers and carpenters.

Every hospital should have a clear idea of its working procedure in the control of cross infection. The scheme will depend upon numerous local considerations—for example, the design and scope of work of the hospital, and whether it is a short-stay or long-stay hospital. Such a scheme might well be prepared by a Committee representing doctors, nurses, laboratory workers and administrators (for cross infection affects the work of all), and it should be the basis for standing orders which all hospital personnel would be required to know and obey. The Committee might also make plans for the detection and investigation of outbreaks, and for arranging courses of instruction for the staff. In hospitals where this latter has already been done, the nurses have greeted the innovation with great enthusiasm: for the first time, they have received an explanation and understanding of practices which they had previously learnt by rule of thumb. The present memorandum may well serve as a guide for the instruction of nurses and students, and it contains, in an

Appendix, suggestions for the demonstration in the laboratory of certain problems of cross infection.

Hospital Committees and administrators are reminded that cross infection is a steady drain on the hospital purse and efficiency. Overhead expenses continue and admissions are delayed while wards are in quarantine. Individual patients detained on account of intercurrent disease may even die, and are, in any case, a continuing source of expense and anxiety. For these reasons, requests for improvements and equipment calculated to lessen the risk should receive careful attention. When building is contemplated, the prevention of cross infection should be an overriding consideration, and expert advice should be sought.

All the procedures recommended in this memorandum have been seen in practice during the war, although some of the measures proposed have not yet been applied on a wide scale. The Sub-Committee on Cross Infection, anxious to learn from the experience of others, will welcome comments and criticism of the memorandum and its recommendations. It is indebted to many medical superintendents, medical officers of health, resident medical officers, matrons, ward sisters and nurses for their help and advice, and, in particular, it thanks the Sister Tutor Section of the Royal College of Nursing, whose special Advisory Sub-Committee has given great assistance.

I. PREVALENCE AND CONSEQUENCES OF CROSS INFECTION

Wherever healthy children congregate, whether in home, school or nursery, there is always a danger that infection may spread among them. Additional risks arise when sick children are housed together in hospital, for they are liable, by reason of their primary disorder, to suffer more seriously than healthy children, should they become infected. Moreover, some of them are certain to be sources of infection to others.

Medical officers of infectious diseases hospitals have long been keenly aware of the risks of cross infection with specific fevers, and have taken measures to minimise their spread. The danger, however, is not limited to fevers which present a clear-cut clinical picture and a predictable epidemiological pattern. The problem today also includes those cross infections which are less easily recognisable as such, and which do not produce unmistakable clinical effects. These may occur both in general and in infectious diseases hospitals, and are particularly insidious among groups of infants and young children. Recent bacteriological advances have linked into a chain of connected events many infections which, on account of their varied clinical manifestations, had previously appeared unrelated. The meaning of the term "cross infection" has become wider and it now includes this miscellany of non-specific infections, as well as the specific fevers; it covers today any infection acquired in the hospital environment.

Clinically, cross infection is manifested as respiratory, gastro-intestinal, wound, skin or mucous membrane infection, arising during the course of another disease. Bacteriologically, it implies the acquisition by a patient of pathogenic micro-organisms not present on admission to hospital.

1. *Respiratory infection.* The most prevalent type of cross infection is respiratory. It takes a variety of forms, e.g. tonsillitis, rhinitis, common cold, otitis media and pneumonia. If tonsillitis due to haemolytic streptococci is accompanied by a rash, it is known as scarlet fever. In infants, respiratory infection may not assume one of these definite forms, but gastro-intestinal disturbances may predominate and lead to wasting, with otitis media, pneumonia, pyuria or skin sepsis. Respiratory infection accounts for much of the sickness[1] and many of the deaths among infants in hospital.

Haemolytic streptococci and pneumococci are the most frequent causal organisms. The identification of some 30 serological types of haemolytic streptococci[2] has made it possible to trace their spread, and surveys in

children's wards have repeatedly disclosed successions of outbreaks, each due to a particular serological type of streptococcus. The clinical effects produced by one and the same type vary from patient to patient, and, in addition to respiratory conditions, they may include wound sepsis, puerperal sepsis, erysipelas, impetigo, etc. [3, 4, 5] In multiple-bed scarlet fever wards, as many as 70 per cent of the patients may become cross-infected with a type of haemolytic streptococcus different from that of the primary disease, and these cross infections are responsible for many of the late complications and second attacks.[6] A survey in a measles ward revealed that 50 per cent of the patients acquired haemolytic streptococci during hospitalisation, and that, as a result, 19 per cent of all the patients developed otitis media.[7]

Cases of diphtheria occur in general and infectious disease wards for children. Bacteriological cross infection by *gravis*, intermediate and *mitis* types of diphtheria bacilli occurs in diphtheria wards.[8, 9] Though without clinical significance, it leads to delay in obtaining negative discharge swabs, owing to prolongation of the carrier state.

The viruses of measles and chicken-pox gain entrance through the upper respiratory tract. Owing to their high infectivity, they frequently cause outbreaks which are difficult to control. Outbreaks of whooping cough, rubella, infective hepatitis, and mumps, also occur, but less frequently.

Thrush may spread among newly-born infants in maternity wards and has been known to prove fatal.[10]

2. *Gastro-intestinal infection.* The spread of gastro-enteritis in wards is responsible for a high morbidity and fatality rate among infants in hospital.[11] Patients with pyloric stenosis[12] or marasmus are particularly susceptible, but healthy infants, admitted, for example, for minor operations, may also become infected. The case-fatality rate is high and may reach 70 per cent. Primary gastro-enteritis of infants behaves as if caused by a specific micro-organism, infecting the bowel and excreted in the stools. Dysentery and Salmonella bacilli have been isolated from some of the patients, but in the majority no pathogenic organism has been found. Secondary gastro-enteritis of infants is associated with, and possibly caused by, infection elsewhere in the body, usually of the respiratory tract and produced by a diversity of bacteria.

Epidemic diarrhœa of the newborn occurs among infants in maternity units. It is a distinctive clinical entity and a highly fatal infection. Recently, several outbreaks have been recorded in this country[13] and many in the United States.[14] No specific causal agent has been isolated, in spite of careful bacteriological investigation.[15]

Bacillary dysentery not uncommonly spreads in children's wards. It may prove fatal to infants and young children, especially if they are wasted or weakly. Older children usually suffer from a mild attack of diarrhœa, with or without blood and mucus in the stools, and recover in a few days. Missed cases and carriers, both convalescent and contact (see p. 7), are common. The causal organism is most commonly *Bact. sonnei*[16] and less frequently *Bact. flexneri*. Enteritis associated with *Giardia* (*Lamblia*) is probably more frequent than has previously been believed.

Outbreaks of typhoid and paratyphoid fevers occasionally occur.[17] They are usually due to food, milk or ice infected by a carrier among the food-handling staff either of the hospital or of the suppliers. They may also result from the transfer of infection from a convalescent or carrier patient, or especially from a mild unrecognised case.

3. *Wound infection.* Pathogenic bacteria may be introduced to a clean wound or burn,[18, 19] or to an already infected wound or abscess. The resulting infection may cause delay in healing, abscess formation, erysipelas, cellulitis or septicaemia. The breaking down of a wound, e.g. a cleft palate incision or a skin-graft, may nullify the expected benefit of the operation. The tonsillar and adenoidal beds after operation are especially liable to infection, which may lead to otitis media or mastoiditis.[20] Haemolytic streptococci

and staphylococci are the commonest organisms causing cross infection of wounds.[21] One or other of the serological types of haemolytic streptococci may produce an outbreak of concurrent respiratory and wound infection.

4. *Skin and mucous membrane infection.* Impetigo, ringworm of the hairy scalp, scabies and pediculosis are liable to spread in wards. In maternity units, outbreaks, which may be serious, of " pemphigus " due to staphylococci are not uncommon among newly-born infants.[22] Concurrently the staphylococci often cause infections, such as mastitis, among the mothers, and other infections, such as ophthalmia, among the infants.

Of mucous membrane infections other than those of the upper respiratory tract, conjunctivitis and vulvo-vaginitis are the most important. Vulvo-vaginitis may be caused by a number of organisms, including haemolytic streptococci and gonococci. Gonococcal vulvo-vaginitis is not common, but it tends to spread rapidly unless stringent precautions are taken.[23]

II.—SOURCES AND MODES OF INFECTION

1. The sources of infection in a hospital may be listed as follows:—

(*a*) The clinical case in which the infection is evident by its signs and symptoms.

(*b*) The missed case in which, owing to the triviality of the symptoms or to lack of proper care, infection fails to be recognised.

(*c*) The patient in the incubation period of an infection, who may be infectious before the onset of the disease.

(*d*) The carrier. A person either convalescent from a clinical infection (= convalescent carrier), or having no obvious disturbance of health (= contact or " healthy " carrier) may harbour infectious organisms. The symptomless carriers in outbreaks of certain infectious diseases not uncommonly outnumber the clinical cases. They are a danger to others because their infection passes unrecognised unless discovered by bacteriological investigation.

2. The spread of infection is by the secretions, excretions and discharges of patients, staff and visitors:—

(*a*) Respiratory: nose and throat secretions; ear, mastoid and sinus discharges; sputum.

(*b*) Gastro-intestinal and urinary: faeces; vomit; urine.

(*c*) Cutaneous: discharges from septic skin lesions; discharges from mucous membranes, e.g. conjunctiva, vagina.

(*d*) Wounds: discharges from septic wounds, burns and abscesses.

3. The modes of spread of infection in a hospital are by direct contact, by a variety of vectors (" mediate infection "), by droplets and by dust.

A. Contact and mediate infection

(*a*) *By persons.*—The skin, particularly of the fingers and hands, of patients and staff is liable to contamination by contact with their own and other persons' infected secretions, excretions and discharges; with articles contaminated by these; and with dust from furniture, floor, personal clothes, etc. Bacteriological tests have shown that fingers and hair bear upon them organisms identical with those found in the throat and nose of the individual examined.[24] Nurses are especially prone to septic skin conditions, such as boils and whitlows, and infective pus from these lesions may be carried on the fingers.

(*b*) *By clothes.*—Personal clothes of hospital staff may become contaminated with discharges, etc., during their ward duties, and may thus carry infection to others. Widespread infection has been demonstrated of the clothing of persons harbouring pathogenic bacteria, e.g. haemolytic

streptococci, in the nose or throat.[24] Handkerchiefs, and the pockets in which they are carried, become heavily contaminated with naso-pharyngeal organisms.

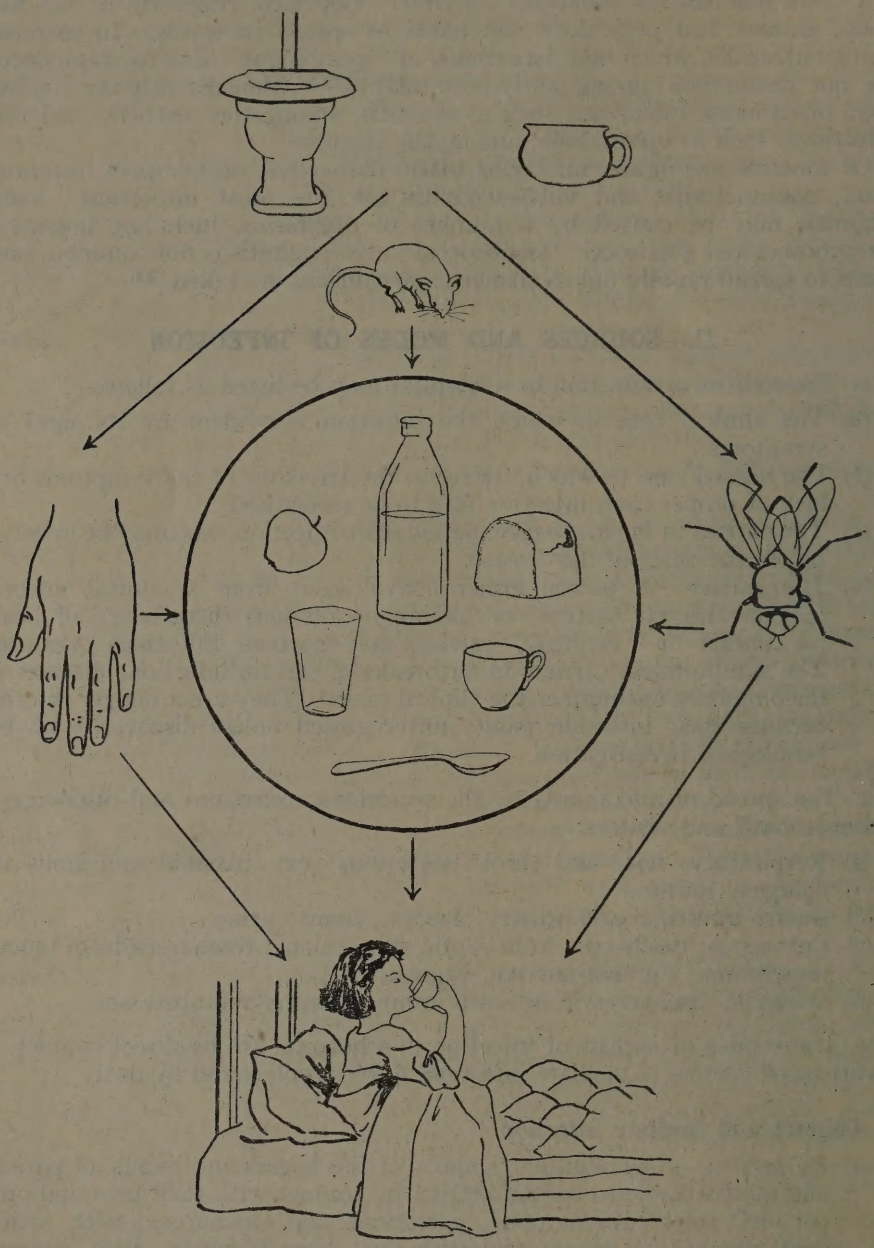


FIG. 1.—Diagram illustrating the spread of Gastro-intestinal Infection

(*c*) *By ward articles.*—Every article in a ward, unless it has been sterilised, has living bacteria upon it. This contamination may be due to settling of infected dust, to handling by persons, or to contamination by infected excretions, etc., of the patients or staff.

Organisms from the respiratory tract—e.g. haemolytic streptococci, diphtheria bacilli, pneumococci, tubercle bacilli—may be carried on thermometers, china, cutlery, pencils, toys, sputum mugs, spatulas, aural and throat instruments, etc.

Organisms from the gastro-intestinal and urinary tracts—e.g. coliform, dysentery, paratyphoid, typhoid bacilli—may be carried on bedpans, urine bottles, chambers, infants' napkins, vomit bowls, rectal thermometers, etc.

Organisms from wounds and abscesses—e.g. staphylococci, haemolytic streptococci—may be carried on surgical instruments, dressings, bandages, plasters over wounds, etc.

If articles are not sterilised between each use by different patients, there is a risk that they may transfer pathogenic organisms from one person to another.

(*d*) *By food.*—Unless food and milk are stored in scrupulously clean, covered containers, they are liable to contamination. Since they promote bacterial growth, their bacterial content increases with storage, particularly if they are not kept in a cool place.

(*e*) *By insects.*—Flies and other insects may act as mechanical vectors of pathogenic organisms. They may transfer gastro-intestinal bacteria from faecal matter to food and milk.

B. Droplet-borne infection

Minute droplets containing bacteria are projected from the mouth and nose for 3 to 6 feet through the air during talking, coughing or sneezing.[25, 26] The larger droplets describe a curved path downwards and may directly infect the nose, throat, eye or wound of a person in close vicinity. Alternatively, they may fall on ward equipment, e.g. a dressing trolley, and infect sterile materials or instruments upon it. Often they fall on bedclothes, personal clothes or on to the floor of the ward, where they dry and finally contribute to the bacterial content of the ward dust. Smaller droplets may evaporate, and leave suspended in the air minute infected particles, known as droplet-nuclei.[27] These may transmit infection for a considerable distance.

C. Dust-borne infection

Bacterial counts of ward air always show considerable rises at the time when the dust content is highest, i.e. at bedmaking and sweeping-times.[28]

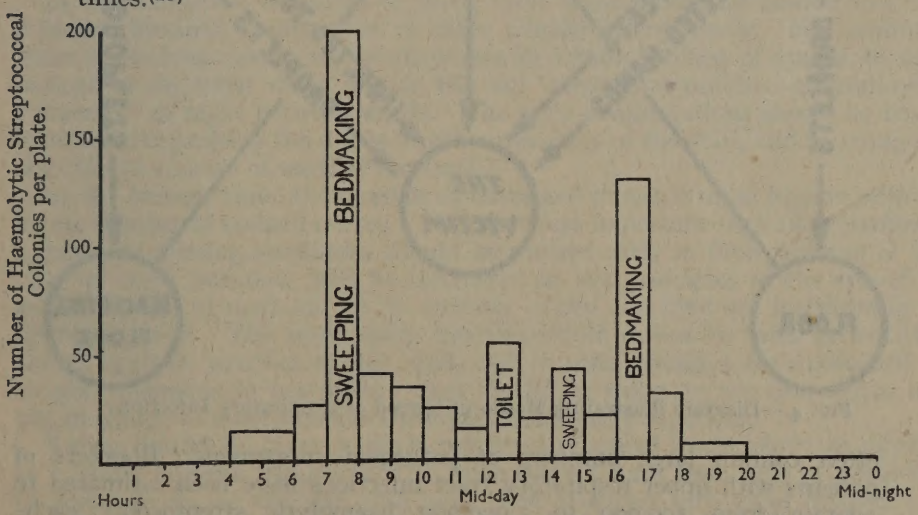


FIG. 2.—Variations in the Numbers of Haemolytic Streptococci in Ward Air during 24 Hours

Dry sweeping, in particular, raises the dust and therefore increases the bacterial content of the air. The dust eventually settles on the furniture of the ward, on the patients themselves and on their bedclothes,

food, toys, crockery, etc. It is actively inhaled into the respiratory tracts of persons in the ward, and bacteria may thus become implanted on susceptible tissues and set up infection.[29]

Floor dust often contains large numbers of pathogenic bacteria, which may remain alive and infective for weeks, or even months, in a dry state. They are especially abundant in the dust of wards where patients with

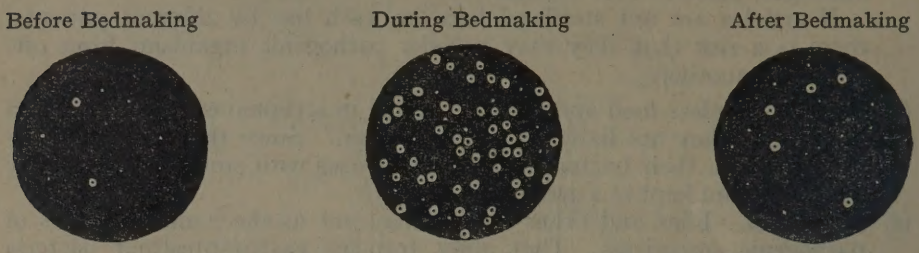


FIG. 3.—Plate Cultures of Aerial Streptococci before, during, and after Bedmaking

upper respiratory tract infections are being nursed. Large numbers of virulent diphtheria bacilli have been isolated from the floor dust of diphtheria wards.[30] It has been estimated that in the floor sweepings of an ear, nose and throat ward 100,000,000 haemolytic streptococci were present.[31] Tubercle bacilli, staphylococci, pneumococci and even paratyphoid bacilli have also been isolated from ward dust.

Bacteria in the dust of wards come mainly from bedclothes, which

FIG. 4.—Diagram illustrating Modes of Spread of Respiratory Infection

often contain large numbers of pathogenic organisms. Blankets of patients with upper respiratory tract infections have been estimated to contain from 500,000 to 1,000,000 haemolytic streptococci each. Every time that a blanket is moved, bacteria are scattered from it. Even straightening the bedclothes of one bed is enough to raise the bacterial count of the surrounding air one hundred times.[31]

Dust also contains scales of skin, hair, finger-nail cuttings, etc., all of which may bear pathogenic bacteria.

III.—THE PREVENTION AND CONTROL OF CROSS INFECTION

1. General Administrative Procedures.

The risk of cross infection among children is serious unless there is available an adequate number of isolation units, and of nurses trained in the prevention of infection. Children should not be admitted to hospital unless they definitely require nursing care and medical treatment, and they should not be accepted for trivial ailments if this can possibly be avoided. They should not be retained in hospital longer than their condition demands. A reduction in the number of children in hospital would considerably relieve the present overcrowding of wards and overwork of staff. With fewer patients to deal with, the ratios of nurses to patients, and of domestic staff to nurses, would approximate more closely to the optimal. Moreover, the number of children in each ward could be reduced; and the nurses could devote more attention to the maintenance of a high standard of medical and surgical aseptic nursing technique.

The large, open, undivided ward must be considered as obsolete. Structural subdivision into smaller units is the modern tendency in ward construction, and it should be encouraged and undertaken as opportunity arises. To satisfy present-day requirements, nearly half the number of beds in a children's or infectious diseases hospital should be in individual cells,* and the remainder in small units. These allow of the distribution of patients according to medical hazards, rather than according to age, as is the custom in some hospitals with wards for children. They make possible the separation of known infected patients from uninfected patients, and the grouping together of infectious patients from a common environment. It is desirable that the distribution of patients in the isolation units should be entrusted to a senior medical officer with an understanding of the risks involved.

Co-operation with the Medical Officer of Health of the district in which the hospital is situated should be encouraged. He should be promptly informed of the occurrence in the hospital of diseases notifiable under statute, and it should be borne in mind that he is also available for consultation and assistance in the control of other infections.

In the allocation of nurses to duty, their work should be related to cross infection hazards, rather than to other administrative needs. For example, there is obvious risk in the employment in a milk kitchen of nurses on outpatient or on toilet duty, and in the not uncommon practice of employing "runners" at night between wards. The same considerations should be borne in mind in organising the duties of other members of the staff, and in arranging the clinical courses of medical students.

At the present time, the number of untrained nurses is often high in relation to the number of trained nurses. It is therefore important that all probationer nurses and nursing auxiliaries should be warned early in their training of the risks of cross infection, and be instructed in the principles of the spread of infection, and of methods for its control. They can then act intelligently as problems arise. The ward sister has important duties to fulfil in teaching sound hygienic practice to her staff, and in maintaining a high standard of aseptic technique in her ward. Care should be taken to see that she is not put in charge of more patients than she can properly supervise.

Nurses should be given a short course of practical bacteriology as applied to hospital hygiene (Appendix F). Such courses have been held in a number of hospitals during the war, and have been attended with great interest and enthusiasm. Domestic, kitchen and porter staffs should be given elementary instruction in hygiene and its relation to their particular duties and responsibilities.

* A cell is the term commonly used in hospitals to denote a small room with walls extending from floor to ceiling; a cubicle is a small room with walls which do not reach from floor to ceiling.

2. Admitting Procedure

The admission of patients—particularly child, maternity and infectious disease patients—direct to open wards without preliminary examination is strongly to be deprecated. Every patient should be seen by a medical officer in an admitting room. The medical officer should make a history and an examination regarding both the condition for which the patient seeks admission and the patient's standing with regard to infectious disease. He should note the dates of previous infectious diseases, recent contact with infection, and the immunisation history. He should look for prodromal signs, nasal and aural discharges, tonsillitis, diarrhœa and vomiting, skin infections, signs of past infections, etc. The decision whether or not to isolate the patient should be made in the admitting room and instructions sent to the ward accordingly. For the examination, the patient should be wrapped in a disinfected blanket (see Appendix A), and placed on a couch. He can later be taken to the ward in this blanket, which, if not soiled, can serve as his bath blanket.

In the admitting room, or as soon as possible after arrival in the ward, appropriate swabs should be taken from patients with upper respiratory infection, discharges, skin infections, etc. Rectal swabs should be taken from patients with diarrhœa and/or vomiting. Upper respiratory tract swabs should be examined for haemolytic streptococci and virulent diphtheria bacilli; rectal swabs for intestinal pathogens; and swabs from other sources for the appropriate organisms.

3. Isolation Nursing

The careful allocation of isolation accommodation is an important measure in the reduction of cross infection. Where cell accommodation is insufficient, selected patients should be nursed in the open ward by the isolation nursing technique (Appendix B), commonly known as bed-isolation or barrier nursing. This method of nursing is for the prevention of contact infection and will not therefore protect against air-borne infection. Cell isolation in itself is not enough to eliminate cross infection, but must be accompanied by careful isolation nursing. Where shortage of nurses and equipment presents difficulties, the bed or cell of any patient for whom the full precautions are essential. should be marked conspicuously with a red disc.

Isolation nursing, whether in cell or open ward, has two main functions:

Firstly, to prevent the spread of infection from infectious patients, i.e. from those with tonsillitis, discharging ear or nose, cold, cough, rash, pyrexia, wound sepsis, abscess, gastro-enteritis, enteric fever, etc.; from those in whom the diagnosis is doubtful; from those in quarantine for an infectious disease; from those suffering from two infections, etc.

Secondly, to protect patients particularly susceptible to cross infection, i.e. all infants under one year of age; surgical patients with ear, nose and throat diseases, cleft palate, pyloric stenosis, burns, open wounds, etc.; weakly or undernourished children.

It should be constantly borne in mind that infants, both healthy and sick, under one year of age incur great risk of contracting gastro-enteritis and respiratory infections in hospital.[32] They should be given priority of cell accommodation, and, whether in cell or open ward, should be nursed by the isolation nursing technique.

4. Immunisation of Patients

Children, who have not been previously immunised against diphtheria and are likely to remain in hospital for four weeks or longer, should be given injections of diphtheria prophylactic. Unless too seriously ill, they should receive a dose of 0.2 c.c. alum precipitated toxoid (A.P.T.) as soon as possible after admission and a second dose of 0.5 c.c. four weeks later. A Schick test should be made about 8 to 12 weeks after the last injection, and children showing

a positive reaction should receive further immunisation. The parents of short-stay patients who have not already been immunised should be informed of the advisability of immunisation and of the local facilities available for it. For the immunisation of adolescents and of adults against diphtheria, toxoid-antitoxin floccules (T.A.F.) or A.P.T. may be used (see below).

Active immunisation against pertussis (whooping cough) may be considered advisable for long-stay patients under the age of 10 years. In field trials, four doses, totalling 70,000–100,000 million killed *H. pertussis*, at weekly intervals[33], or two doses of 10,000 million killed *H. pertussis*, as alum precipitated vaccine[34] at four weeks' interval, have been found to reduce both the incidence and the severity of the infection. As solid an immunity as that given by diphtheria immunisation cannot, however, be expected.

Immunisation against diphtheria and pertussis may be carried out simultaneously. In this case, A.P.T. is injected intramuscularly into one arm and pertussis vaccine at the same time into the other.

The permission of the parents should be obtained before a minor is actively immunised.

5. Chemo-prophylaxis

Final estimates of the value of chemo-prophylaxis in the control of cross infection await further trial, but examples of its already proved use may be given. In mental hospitals, sulphaguanidine has been effective in the control of dysentery[35]; and among rheumatic fever patients, sulphanilamide has prevented recurrences, due to streptococcal infection.[36] It should be noted that sulphonamides in light dosage may engender drug-fast strains, and that prolonged administration may lead to toxic effects.[37]

6. Visiting in children's wards, maternity units and infectious diseases hospitals

Ward visitors may introduce infection, especially of the upper respiratory tract. Visiting should be limited, in both children's general and infectious disease wards, to nursing mothers feeding their infants, to relatives of dangerously ill or long-stay patients, and to relatives home on leave; in maternity units, to husbands or other near relatives. Other visitors should be admitted only at the discretion of the ward sister; and articles of food brought in should be handed to her. Parents and other relatives should be permitted to make enquiries by personal interview or by telephone from the ward sister or doctor in charge. Would-be visitors will co-operate if the reasons for their exclusion are tactfully explained to them. In no circumstances should child visitors be admitted to these wards or units. All visitors should wear face-masks and, where supplies permit, gowns as well.

7. Staff health and hygiene

(*a*) *Immunisation.*—All members of the staff should be actively immunised against diphtheria and enteric fevers (typhoid and paratyphoid). Until their immunity has had time to develop, they should not be allowed to come in contact with these infectious diseases.

Vaccination against smallpox is compulsory for the staff of smallpox hospitals.

For the immunisation of the staff against diphtheria, there are two alternatives: (*a*) if a pre-Schick test is not made, T.A.F. (three doses, each of 1 c.c., at intervals of not less than three weeks) should be used; (*b*) if a pre-Schick test is made, A.P.T. (0.2 c.c. followed by 0.5 c.c. four weeks later) may be used for those who show no pseudo-element in the Schick reaction. (For the immunisation of nurses, diphtheria prophylactic is available free of charge.)

Eight to twelve weeks after the last injection, a post-Schick test should be made. Subjects giving a positive reaction should receive further immunising injections.

It is advisable to reinforce the immunity of young nurses by an additional dose of diphtheria prophylactic two years after their first course of injections.

(*b*) *Medical examination, etc.*—All members of the staff and medical students should have a medical examination, and an X-ray examination of the chest, when they join the hospital and at intervals of 6 or 12 months afterwards. The risk of staff members contracting tuberculosis should be borne in mind.[38] Recommendations for minimising the danger have been stressed in a recent memorandum.[39]

Those who suffer from chronic ear, nose or throat diseases are more liable than others to contract infections and to harbour pathogenic organisms. They must receive effective and bacteriologically controlled treatment, before taking up work among child or maternity patients (see Appendix C).

(*c*) *Sickness.*—All members of the staff—medical, nursing and domestic—and also medical students, should feel it a duty to report minor ailments, such as colds, sore throat, diarrhœa, vomiting, whitlow and skin sepsis. They should be excluded from duty while sick. Where this recommendation is impracticable owing to shortage of staff, anyone with a minor ailment who *must* remain on duty should be kept from contact with infant, maternity and surgical patients, and should not prepare infant feeds. While working elsewhere in the hospital, he (or she) should take strict personal precautions (e.g. by masking, hand-washing, etc.) to avoid the spread of infection.

After diphtheria, enteric fever, dysentery or tuberculosis, staff members or students should not resume work until they cease to be carriers of the causal organism. Time off for sickness should not be deducted from holidays and should not entail financial loss.

It should be impressed on all kitchen and all food-handling personnel that they must report even minor gastro-intestinal disturbances, since these may be due to dysentery or food-poisoning bacilli.

Special precautions for midwives are dealt with in Appendix C.

(*d*) *Personal hygiene.*—Hands should be kept in good condition. A liberal supply of dry towels and hand cream in the wards is essential. Fingernails should be short. Rings, wristwatches or bangles should not be worn on duty. Hair should be short or well pinned up.

8. Labour-saving Methods

Shortage of staff in many hospitals is hindering the carrying out of hygienic nursing methods. Every hospital should therefore concentrate on essentials and make the best use of its skilled staff. Many outmoded peacetime practices should give way to simpler time-saving methods. Nurses should not be assigned to work which others, such as ward orderlies, could do, e.g. cleaning duties, taking messages. In some wards, ambulatory patients assist the staff; this practice is not devoid of risk, as in so doing they may infect others, or themselves become infected. A morning and afternoon collection of pathological specimens from the whole hospital by a porter or orderly will save the nurses many journeys. Non-essential work should be reduced to a minimum, e.g. floors should be spindle-oiled instead of polished. In the laundry, priority should be given to work essential for good nursing, i.e hand-towels, bed-linen, masks and gowns. At present, labour and materials are unnecessarily used in starching and hand-ironing aprons, collars and cuffs.

Certain time- and labour-saving devices could be adopted even during the war. Pedometer measurements showed in one hospital that $7\frac{1}{4}$ miles were walked by the staff in the distribution of one meal. When trolleys were used instead of individual trays, this mileage was much reduced. Heavy articles, such as screens, soiled linen stands, etc., should be mounted on wheels, in order to save the nurses' time and energy. Screens, even in adult wards, need be used much less than at present. If thermometers and their vials are fitted into racks, they can be carried from bed to bed in an open ward, so avoiding separate

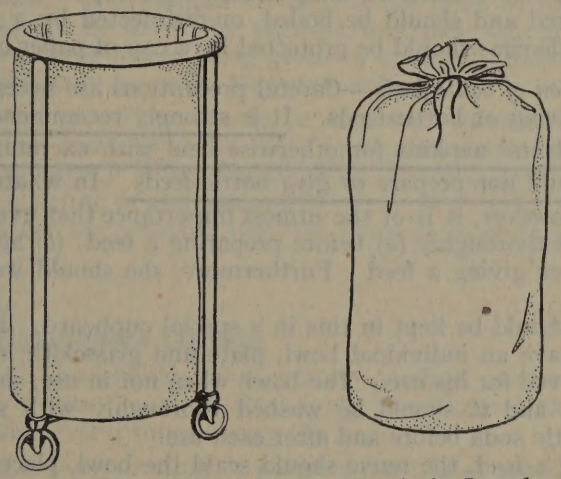
journeys for each one. These are merely a few suggestions. No doubt the nurses, with the help of the hospital engineer and carpenter, could devise many more improvements and improvisations.

9. Control of Contact and Mediate Infection

(*a*) *Hand-washing.*—Members of the staff should wash their hands thoroughly with soap and running water on the following occasions: *before* preparing or giving drinks, meals or bottle-feeds; examining a patient; *after* attending to a patient's nasal or oral toilet; dealing with excreta; changing a napkin; handling used crockery; sorting soiled linen; cleaning or dusting; arranging pathological specimens; examining a patient.

It is important that the staff, including food-handlers, should wash their hands well after any risk of personal contamination, i.e. after using the water-closet, guarding a sneeze, etc. It is strongly recommended that on the inside of all hospital water-closet doors should be written conspicuously "NEXT WASH YOUR HANDS!" No roller towels should be allowed in any part of a hospital.

(*b*) *Laundry.*—Great care should be taken in the handling of soiled linen, as contamination may occur from discharges and from the scattering of dust particles. Soiled linen bags of canvas on wheeled frames are convenient for collecting linen from the bedside. Soiled linen should never be counted or sorted in the ward or its annexes. It should be sent, uncounted, direct to the laundry, and should be received there by responsible sorters. They should be the only persons in the laundry to handle soiled linen before it goes to the wash.



In Ward Ready for Laundry

FIG. 5.—Soiled Linen Bag and Frame

Disinfection before laundering (Appendix A) is necessary for linen, gowns, etc., from patients with enteric fever, dysentery, gastro-enteritis, and infestations, and for linen and garments soiled with discharges or excreta.

Infants' napkins should not be scrubbed out in the ward. So far as wartime supplies permit, an individual sanitary bin containing diluted "white fluid" (pp. 23, 24) should be provided beside each cot. As a wartime expedient, an enamelled pail may be used. The napkin after removal should be placed direct into this bin and should not be handled again in the ward, but should be tipped from the individual bins into a common bin containing diluted "white fluid." The laundry should have special means of dealing with napkins, i.e. either a special napkin washing machine, in which napkins can be washed without preliminary cleansing, or a special laundress allocated to the scrubbing out of napkins before they are washed. All napkins should be boiled during the washing process.

(*c*) *Food.*—Resistance against infection is promoted by an adequate and well-balanced diet. Dietaries of patients and staff, particularly in wartime, should be periodically reviewed in respect of caloric value, protein, fat, carbohydrate, vitamin and mineral content. [40]

All kitchens and storerooms should be kept scrupulously clean, free from vermin and, where possible, fly-proofed. For disposal of food remnants, see Appendix A (p. 25).

(*d*) *Breast-feeding.*—Breast-fed infants are considerably less prone to gastro-intestinal and respiratory infections than bottle-fed infants. Nursing mothers should therefore be urged to continue the breast-feeding of their infants in hospital. Every possible obstacle should be overcome. The hospital should arrange a comfortable waiting-room for nursing mothers, and living accommodation for those from a distance. The expense of the mother's fares should, where necessary, be met by the hospital.

In maternity units, if special treatment of the mother's nipples is required, an individual tray with sterilised swabs, bowls, etc., should be provided for each patient.

(*e*) *Cow's milk.*—Raw milk should never be given to infants or children. Pasteurisation of milk, if properly carried out, renders it safe. As an additional precaution, however, under present wartime conditions, it is advisable to bring to the boil all milk for infants and children, cool it rapidly in covered containers and keep it, whenever possible, in a refrigerator. Internal arrangements for storage and distribution of milk should be scrupulously clean. Vessels should be covered and should be boiled, or disinfected by a steam jet, after each use. Bottle rims should be protected by a cap of paper or metal.

(*f*) *Preparation of bottle-feeds.*—Careful precautions are necessary in the preparation and giving of bottle-feeds. It is strongly recommended that nurses who change infants' napkins (or otherwise deal with excreta, or with septic conditions) should not prepare or give bottle-feeds. In whatever way duties are arranged, however, it is of the utmost importance that every nurse should wash her hands thoroughly (*a*) before preparing a feed; (*b*) after changing an infant; (*c*) before giving a feed. Furthermore, she should wear a face-mask throughout.

Dried milks should be kept in tins in a special cupboard. Every bottle-fed infant should have an individual bowl, plate and glasscloth, marked with his name and reserved for his use. The bowl, when not in use, should be covered with his plate, and it should be washed thoroughly with soap and water containing a little soda before and after each use.

Before giving a feed, the nurse should scald the bowl, place the bottle containing the feed in it, and surround the bottle with warm sterile water (at about 100° F.). She should cover the bowl with the plate until the infant is ready for feeding.

When feeds are finished, the bottles should be washed out in running cold water, and the teats and valves turned inside out and gently scrubbed to remove all traces of feed. Bottles, teats and valves should then be placed in cold water in a special steriliser (as an improvisation, a fish-kettle over a gas or electric heater will serve); they should be boiled for 2 to 5 minutes, left in the steriliser until required again and then re-boiled for 2 to 5 minutes. The full procedure should be followed before and after each feed. Bottle-feeds should be prepared by a senior member of the nursing staff.

The preservation of rubber teats and valves, when not in current use, is important. They should be kept dry by storage in dry salt in an air-tight container.

(*g*) *Milk kitchens.*—Some hospitals prefer a central milk kitchen, serving the whole hospital; others prefer ward milk kitchens. A central milk kitchen

has the advantages of being more economical of staff and equipment, and of a personnel not exposed to ward infections. Should, however, any contamination be introduced, infection may become widespread in the hospital. In ward milk kitchens formulas can be more rapidly changed to suit an infant's requirements, and nurses in training see the direct results of the feeds they have prepared. On the other hand, as the staff is in direct contact with patients, there is greater risk of contamination.

A central or ward milk kitchen should fulfil certain requirements. It should be reserved solely for the preparation of infant feeds; be situated as far as possible from sluices, water closets, etc.; be fly-proof; contain equipment for rinsing, cleaning and sterilising feeding bottles, have running hot and cold water laid on, and be fitted with hand basin, covered containers, racks for feeding bottles, gas or electric cooker, refrigerator, etc. It should be in the regular charge of a sister or staff nurse, who will supervise and teach nurses regarding infant feeds. Staff members should wash their hands thoroughly and don gowns and face-masks before starting work. They should be left free from interruption while in the milk kitchen. Unauthorised persons should not be admitted.

(*h*) *Temperature-taking.*—Temperatures of infants and children should not be taken in the mouth. As far as supplies permit, an individual thermometer should be reserved for each patient. For disinfection, see Appendix A (p. 24).

(*i*) *Playthings.*—Toys, papers, books, etc., should preferably be provided by the hospital and not be brought in by patients or their relatives. All toys should be washable. They should be tied to the head or foot of the bed. Playthings should not be shared by patients, and they should be disinfected after use by one patient before being given to another. Balls should not be allowed, and pencils only for older, long-stay children.

(*j*) *Surgical dressings.*—These should be done with meticulous attention to aseptic precautions (see Appendix D). Particular care should be taken to apply bandages firmly when dealing with children; otherwise they will disturb them by fidgeting or pull them off.

The technique for the perineal toilet of lying-in patients is described in Appendix C.

10. Control of Droplet-Borne Infection

(*a*) *Ventilation.*—This should be as free as possible, winter and summer, day and night. Wards should be thoroughly aired immediately before and after blackout, and several times during the night.

(*b*) *Bed-spacing.*—Overcrowding of patients must be avoided. In multiple-bed wards for infectious diseases, the distance between bed-centres should be not less than 12 feet (Ministry of Health recommendation). In children's general wards, and in maternity units, this distance should, wherever possible, be adhered to, and in no circumstances should the distance between bed-centres be less than 8 feet.

(*c*) *Face-masks*—Efficient face-masks[21] should be worn by members of the staff as follows:—while attending to infants under one year of age, i.e. while feeding, bathing, changing or examining them; preparing infants' feeds; doing surgical dressings or arranging dressing trolleys; attending to surgical, ear, nose, throat or mouth patients; attending to puerperal patients; during ward outbreaks of respiratory infection. They should also be worn by visitors to children's or maternity wards, and by nursing mothers while breast-feeding.

It is dangerous to touch the inside surface of masks, for the fingers will thus become contaminated with pathogenic organisms from the respiratory tract. For the same reason, masks should not be left about the ward, nor carried in the pocket or apron front. They should not be re-worn after having been

discarded. Immediately after use, they should be placed in a bowl of diluted liquor chloroxylenolis (see p. 24). At the end of the day the soiled masks should be boiled, rinsed out and ironed. A liberal supply of clean masks should be placed in a conspicuous position in the ward.

(*d*) *Aerial disinfection.*—Research workers are at present attempting to control aerial infection by means of ultra-violet irradiation[41] and by disinfectant vapours[42] or mists (aerosols).[43] These methods, however, are ineffective where bacteria are carried by gross particles, such as dust.

11. Control of Dust-Borne Infection

(*a*) *Bedclothes.*—Blankets and pillows should be handled gently, to minimise the scattering of dust particles. Bedclothes of one patient must not be placed on the bed of another. They should not be allowed to touch the floor. Impregnation of blankets with "technical white oil" reduces very materially the number of bacteria scattered from them.[44] The method, if successful in ward trials, may be adopted for general use.

(*b*) *Floors.*—Floors of wards and passages, if of wood or covered with linoleum, should be treated with spindle oil (Appendix E, p. 30). After oiling, the dust becomes matted together in rolls and does not rise during sweeping.[45] Wards with oiled floors are noticeably less dusty than others. Labour and materials for floor-polishing are saved. Rubber, composition and concrete floors should not be oiled, but either washed, vacuum-cleaned, or sprinkled with damp sawdust before sweeping. All dusters should be damped with diluted "white fluid" (p. 23) before use, and no dry dusting should be done.

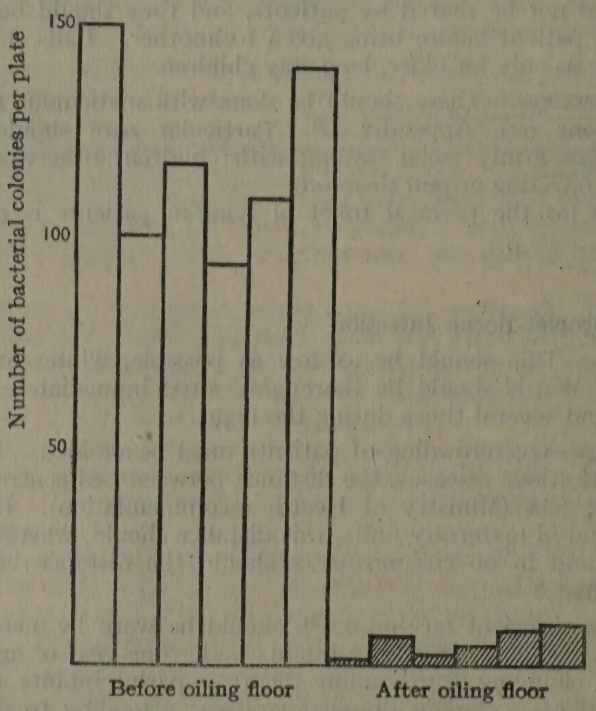


FIG. 6.—Bacterial Counts of Ward Air during Sweeping

(*c*) *Cleaning duties.*—Dust is heavily contaminated with pathogenic bacteria. Nurses, therefore, should not undertake cleaning duties, and ward maids should not undertake nursing duties. Ward maids should wear gowns while cleaning, and should remove them and wash their hands and forearms thoroughly before performing other duties.

A cupboard or small room should be reserved for dusters, cleaning articles, brooms, etc. They should not be kept about the ward or kitchen. Dusters and floor-cloths should not be washed out in kitchen sinks, ward hand-basins or baths.

(*d*) *Protection from dust.*—Sterile materials, sterile instruments, food, milk, etc., should be kept in covered containers, to protect them from dust. Crockery, glasses, cutlery, etc., should be kept in drawers or cupboards. Plates should be stacked in piles and covered with clean towels after washing up.

Any article which falls on the floor should be regarded as infected and should be disinfected, preferably by heat, before being used again. If this is impracticable, it should be thoroughly washed with soap and hot water.

IV.—PROCEDURE FOLLOWING THE OCCURRENCE OF INFECTION IN A WARD

Precise instructions to be followed on the occurrence of infection in a ward cannot be given, since the procedure will depend on a number of factors, including the nature, infectivity and clinical severity of the infection; the methods of its spread; the susceptibility of the contacts; the extent of the outbreak; the duration and proximity of the exposure of susceptible contacts; and whether the patient who developed the infection was incubating it on admission, or acquired it in hospital.

1. Certain *general measures* may, however, be advised:—

(*a*) All clinical or suspected cases should forthwith either be nursed by the isolation technique in cells or in the open ward, or else be removed to an infectious diseases hospital.

(*b*) All patients who are particularly susceptible to the infection, or to whom it would be particularly dangerous, should be nursed by the isolation technique, either in cells or in the open ward; if possible, only immune nurses should attend to the clinical cases of the infection.

(*c*) Bacteriological investigation of the clinical cases should be made, to discover the causal organism.

(*d*) A clinical and bacteriological search should be made for the source of the infection, if it appears to have been acquired in the hospital.

(*e*) During the period when secondary cases may be expected, all patients in the ward should be kept in bed and should be examined every twelve hours for prodromal signs and symptoms.

(*f*) Admission of new patients may be continued as far as is consistent with safety (see below).

2. *Additional special precautions,* as indicated below, should be taken when any of the following cross infections develops in hospital:—

A. Haemolytic Streptococcus Infection

(*a*) When allocating clinical cases to isolation, the numerous and varying manifestations of haemolytic streptococcus infections must be kept clearly in mind. These include scarlet fever, tonsillitis, cervical adenitis, rhinitis, sinusitis, otitis media, mastoiditis, skin sepsis, impetigo, wound suppuration, cellulitis, erysipelas, puerperal pyrexia and sepsis, and simple pyrexia.

(*b*) Noses, throats and any discharges, abscesses, infected wounds, etc., of patients should be swabbed and examined for haemolytic streptococci. All patients carrying haemolytic streptococci (Group A Lancefield) and having clinical upper respiratory tract infection, unhealthy nasal passages or fauces, wound sepsis, etc., or yielding a profuse growth of these bacteria in the absence of clinical signs, should be nursed by the isolation technique in cell or open

ward. They should not be released from isolation until they show no clinical evidence of infection, and at least two successive negative swabs, at an interval of not less than three days, have been obtained.

(*c*) All members of the ward staff should be adequately examined for sore throat, running cold, skin sepsis (particularly of the fingers or hands) and other manifestations of infection. All staff members showing signs or symptoms of haemolytic streptococcus infection should be taken off duty until they have recovered and have ceased to be heavy carriers.

(*d*) In the event of wound or burn sepsis, the additional precaution should be taken of overhauling the surgical and dressing technique of the ward and operating theatre.[21, 46]

(*e*) Special precautions for maternity units are dealt with in Appendix C.

B. Diphtheria

(*a*) No new patients should be admitted to the ward.

(*b*) Noses, throats and any discharges of patients and ward staff should be swabbed and examined for virulent diphtheria bacilli.

(*c*) Pending a report on the virulence of the organisms, all patients carrying diphtheria bacilli should be nursed by the isolation technique in cell or open ward, and all members of the ward staff found to be carrying diphtheria bacilli should be kept off duty.

(*d*) Patients or staff members who are carriers of virulent bacilli, if in a general hospital, should be kept in isolation for observation and treatment (but if the isolation accommodation of the general hospital does not, as it should, suffice for this, they should be sent to an infectious diseases hospital); if already in an infectious diseases hospital, they should be nursed by the isolation technique in cell or open ward.

(*e*) Children who have already been immunised against diphtheria should be injected with 0·2 c.c. of alum precipitated toxoid (A.P.T.) to reinforce their immunity. Young nurses who have received no immunising injections for two years or more should be given an injection of toxoid-antitoxin floccules (T.A.F.).

(*f*) Children who have not been immunised against diphtheria, and who are likely to remain in the hospital for four weeks or longer, should receive combined active and passive immunisation[47], i.e. 500 units of diphtheria antitoxin in the right upper arm and simultaneously 0·2 c.c. A.P.T. in the left upper arm. Four weeks later, they should be injected with 0·5 c.c. A.P.T.

(*g*) Children who have not been immunised against diphtheria, and who are unlikely to remain in hospital for as long as four weeks, should receive passive immunisation only, i.e. 500–1000 units of diphtheria antitoxin.

(*h*) Following an outbreak of diphtheria, the ward may be reopened, after disinfection (see Appendix A, p. 26), when all clinical cases have been removed, and at least two successive swabs from every patient and member of the ward staff, at an interval of not less than three days, are negative as regards virulent diphtheria bacilli.

C. Measles

(*a*) The occurrence of a primary case of measles will usually be followed by secondary cases among susceptible children unless adequate precautions are taken.[48] Removal of the primary case at the eruptive stage will not lessen the risk to susceptible contacts.

In some hospitals it is the practice to separate all susceptible contacts by placing between them children with a history of measles, thus lessening the risk of close contact should secondary cases arise.

The history of a previous attack is often unreliable, and if there is any doubt, the child should be regarded as non-immune.

(*b*) As regards specific prophylaxis, there is a choice of two alternatives:—

i. To protect completely all susceptibles with convalescent serum, and to continue to admit fresh patients.

ii. To protect completely all children under 3 years of age and older debilitated children; to modify the attack in older robust patients and to put the ward in quarantine for 21 days (modification of the infection by immunisation may prolong the incubation period).

Protection lasts for 2 to 3 weeks only; a modified attack confers lasting immunity. While, therefore, the latter alternative is more desirable for the children at risk, from the administrative point of view it is often essential or expedient to aim at complete protection.

Complete protection can be ensured only by the injection of appropriate doses of pooled convalescent serum within 5 days of exposure (in estimating this, it must be kept in mind that measles is infectious for 3 to 4 days before the rash appears). Larger doses of adult serum or whole blood, or placental extract, may protect with less surety.

To modify an expected attack, convalescent serum may be used in smaller doses. It is advisable to conserve the limited supplies of convalescent serum for complete protection, and to use adult serum or whole blood, or placental extract, where modification is desired. Reactions after the injection of human serum are rare, but jaundice has developed 2 to 4 months after the use of certain batches of serum.

A scheme of dosage for the prevention or modification of measles is shown in the following table:—

A. For children under 3 years of age injected within five days of exposure.

Reagent	Protection	Modification
Convalescent serum	5 c.c.	2.5 c.c.
Adult serum	10 c.c. (Less dependable)	5 c.c.
Adult whole blood	20 c.c. (Less dependable)	10 c.c.

B. For children over 3 years of age injected within five days of exposure, double these amounts should be used.

D. Pertussis (Whooping Cough)

(*a*) No new patients under the age of 3 years should be admitted to the ward.

(*b*) Older children should be admitted only if they have a reliable history of an attack of pertussis.

(*c*) Every patient who develops a catarrh or suspicious cough should be nursed by the isolation technique until a diagnosis of pertussis can be excluded by bacteriological and haematological investigations.

E. Gastro-enteritis of Infants

(*a*) The nursing technique, especially with regard to hand-washing after dealing with excreta, and before preparing or giving bottle-feeds, should be scrupulously overhauled.

(*b*) Patients under 2 years of age should not be admitted to the ward until the infection has been brought under control.

(*c*) Clinical cases and contacts should be investigated clinically and bacteriologically for enteral or other infection.

(*d*) Infants with gastro-enteritis should in no circumstances be nursed with patients suffering from dysentery, typhoid or paratyphoid.

F. Epidemic Diarrhœa of the Newborn

(*a*) On the occurrence of a suspected case in a maternity unit, the infant should be isolated from the healthy infants, and be nursed by separate nursing staff. If the infant is breast-fed, it will be necessary to isolate the mother with the child. Bacteriological examination of the infant's stools should be undertaken.

(*b*) If more than one case occurs, the whole maternity unit or block should be closed to new admissions; and affected infants, if necessary with their mothers, should be kept in strict isolation.

(*c*) Inquiry should be made as to whether any members of the staff have had symptoms of diarrhoea or other illness. Where indicated, bacteriological examination of the stools of staff members should be made.

(*d*) The possibility should be considered of discharging home the healthy infants and their mothers. This should be done only where the mother's condition permits of it, and where suitable arrangements can be made by the welfare authority for the mother and child to be looked after until the fourteenth day, after which the health visitor should assume the responsibility of following up the case. This supervision should ensure that if, as may well happen, the infant later develops epidemic diarrhoea, it will not be admitted to another hospital ward under conditions where other infants may be exposed to infection.

(*e*) After discharge of the last patient, the wards, nursery and all articles in them should be thoroughly disinfected. Before the unit is re-opened, all members of the staff should be allowed a short period of leave.

G. Dysentery

(*a*) The nursing technique, especially with regard to handling of food, disposal of excreta, hand-washing after dealing with excreta and before dealing with food, should be scrupulously overhauled.

(*b*) Patients should not be admitted to the ward until the infection has been brought under control.

(*c*) Stools or rectal swabs of patients and staff, including food-handlers, should be examined bacteriologically for dysentery bacilli.

(*d*) Any patient or member of the staff with dysentery bacilli in the stools or rectal swab should be nursed by the isolation technique, or kept off duty, respectively, until at least 3 successive bacteriological examinations at an interval of not less than 3 days are negative and any clinical symptoms have disappeared. A stricter criterion of negativity is required if the patient is proceeding to an institution, such as a nursery school. In this case, 4 to 6 negative results should be obtained within a period of 2 weeks.

H. Paratyphoid, Typhoid and Food-poisoning

(*a*) Stools and urine of patients and staff, including food-handlers, should be examined bacteriologically for the causal organism; blood cultures and serological examinations should be made by the bacteriologist at discretion.

(*b*) Bacteriological examinations should be made of any food articles, milk, ice, etc., considered to be under suspicion. Any remains or containers of the suspected food should be kept for examination.

(*c*) Any patients or members of the staff who are found to be carriers of the causal organism should be nursed by the isolation technique until, by clinical and bacteriological examinations, they can be regarded as free from infection, or until they leave the hospital.

(*d*) The nursing technique should be overhauled as for dysentery.

I. Chicken-pox, Herpes zoster, Rubella or Mumps

Patients who develop any of these infections in hospital should be isolated as promptly as possible. In the case of chicken-pox, however, this measure is frequently unsuccessful in limiting the spread. Sero-prophylaxis is, in general experience, unreliable in these diseases.

3. Vulvo-vaginitis

(*a*) Any patient who develops vulvo-vaginitis should be immediately isolated, and a vaginal swab should be examined bacteriologically.

(*b*) Pending the bacteriological result, no new patient should be admitted to the ward.

(*c*) All female patients in the ward should be examined immediately, and thereafter daily.

(*d*) Nurses should wear gloves while in attendance on the patients.

(*e*) Strict precautions should be taken with regard to hand-washing, temperature-taking, and disinfection of water-closet seats, chambers, bedpans and baths.

(*f*) If the infection proves to be non-gonococcal, the patient(s) with vulvo-vaginitis should be kept in isolation; new patients may be admitted, but a strict technique and vigilance should be maintained.

(*g*) If the infection proves to be gonococcal, no patient should be admitted until the ward is shown to be free from infection, both clinically and bacteriologically. Vaginal swabs should be taken from all female patients and examined bacteriologically, and the strict daily inspection and hygienic precautions should be maintained.

(*h*) If any further case occurs, the bacteriological examination of patients should be repeated.

(*i*) Final bacteriological examination of patients should be made 8 days after the discovery of the last case.

APPENDIX A

DISINFECTION AND STERILISATION

1. Disinfectants

During the war disinfectants should be used with economy. Sterilisation by heat should be employed wherever possible, as it is quicker and more reliable. Addition of 2 per cent washing soda to the water for boiling makes it more lethal to bacteria and diminishes rusting. For general disinfection, the crude coal-tar disinfectants of the "black fluid" and "white fluid" types should be used. More highly purified coal-tar disinfectants e.g. chloroxylenol, lysol, should be reserved for special purposes.

"Black fluids" and "white fluids" are emulsions of phenolic substances. For most purposes "black" and "white" fluids, if of the same efficiency as judged by the Chick-Martin coefficient, are equally suitable. The tendency of "black fluids" to cause staining, however, may be a disadvantage. "White fluids" therefore should be used for linen, etc., and for unstained wood.

(*a*) "*Black fluids.*"—According to the British Disinfectant Manufacturers' Association, the following British proprietary disinfectants are of the "black fluid" type: Antifect; Bactocene; Coetas; Disolite; Exenol superior; Hycol; Hygenol fluid disinfectant; Ialine special; Jeyes' fluid; Kilcrobe 10/12 black; Killgerm 10/12 black; Lawes'; Metro; Monsanto black disinfectant No. 4; Sanitas-bactox; Septol; Special creitas; Cooper's standard fluid; Vitalin No. 99.

(*b*) "*White fluids.*"—The following British proprietary disinfectants are stated to be of the "white fluid" type: Baxol X; Betazone No. 1; Exenol D.A. white; Ialine No. 8; Izal; Jeyes' white cyllin; Kilcrobe 18/20 white; Killgerm 18/20 white; Lawes' L.W.4; Monsanto white disinfectant fluid No. 1; Sanitas-okol; Sal-hycol; Star white; Sterilite; Superlin white; White bactocene; White kerol; White septol; Wright's veterosol; Voxsan M.A.F. disinfectant fluid.

For general purposes, "black" or "white" fluids having a Chick-Martin coefficient of 3·0 should be used at a dilution of about 1 in 160, i.e. 1 fl. oz. to about 8 pints of water; for steeping linen, etc., "white fluid" should be used at this dilution. For disinfection of bedpans, bins, etc., the solutions should

be used at double this strength, and for disinfection of excreta, vomit, sputum, a dilution of 1 in 10 should be used. The strengths and the times needed for the disinfectant action of the proprietary preparations chosen should be checked by the hospital bacteriologist.

(*c*) *Chloroxylenol solutions.*—Liquor chloroxylenolis (B.P.), syn. Roxenol and the proprietary preparations Dettol, Kilsol, O-syl, Peractum, Perkol, Santron, Superlin N.P. fluid, Supersan, Streph, Zant and Zenol are chloroxylenol disinfectants. They are relatively expensive and should be reserved for special purposes, e.g. disinfection of the hands.

For further information regarding the use of disinfectants, the Memorandum by the M.R.C. Therapeutic Requirements Committee—"Economy in use of bactericides"[49] and M.R.C. War Memorandum No. 6—"Prevention of hospital infection of wounds"[21] may be consulted. The information given above, and the recommendations which follow, are in part drawn from these publications.

2. Concurrent Disinfection

(*a*) *Linen.*—If from cases of enteric fever, dysentery, gastro-enteritis, or infestations, or if soiled with excreta or discharges, linen should be steeped overnight in diluted "white fluid" before being sent to the laundry. Every ward should have a bin of disinfectant solution reserved for this purpose, and the laundry should have a "disinfecting tank" for steeping. Other linen may be sent to the laundry without previous disinfection; the boiling process should kill all non-sporing micro-organisms.

(*b*) *Napkins.*—These should be placed directly into a sanitary bin containing diluted "white fluid" and should not be further handled in the ward. They should be dealt with in the laundry (see p. 15).

(*c*) *Face-masks.*—These should be discarded into a bowl of liquor chloroxylenolis (1 in 80 dilution) immediately after use. At the end of the day they should be boiled, rinsed out and ironed.

(*d*) *Handkerchiefs.*—Older children and adults should be provided with bedside bowls in which to keep their handkerchiefs. Bowls and handkerchiefs should be collected with forceps. The handkerchiefs should be discarded into a bowl of liquor chloroxylenolis (1 in 80 dilution) and then sent to the laundry for boiling. The bowls should be boiled.

(*e*) *Baths.*—Cetyltrimethylammonium bromide (CTAB or "Cetavlon") may be recommended for the disinfection of baths and bowls.[50] As an alternative, undiluted lysol, with abrasive if required, should be rubbed over the surface, and the bath should then be rinsed out with water from the tap. Great care should be taken to avoid splashing the face and hands with lysol. Inexperienced members of the staff should be warned of the risk of lysol burns, both to themselves and to patients.

(*f*) *Surgical bowls, dishes, etc.*—These should be boiled for 2 to 5 minutes completely immersed in water. If a ward has no bowl steriliser, it should improvise one. A laundry copper, electric washer, or fish kettle over gas or electic heaters, will serve.

(*g*) *Soiled dressings.*—For the disposal of used dressings, two bins should be provided—one, the salvage bin for dressings which can be used again, e.g. outer bandages; the other, the destructor bin for non-recoverable dressings, which must be incinerated. Recoverable dressings should be covered with lysol 1 in 80 for at least one hour and then be boiled in soapy water for 5 minutes. They should never be washed without preliminary boiling.

(*h*) *Thermometers.*—These should be kept immersed in liquor boracis et formaldehydi (N.W.F.) and be well rinsed in water before use.

(*i*) *Instruments.*—Those in current use in the ward should be sterilised and then stored in liquor boracis et formaldehydi (not in alcohol), and be well rinsed with *sterile* water before use. Hypodermic needles and syringes should

be sterilised by heat. All-glass syringes should be sterilised by dry heat, by autoclaving or by boiling; combined glass and metal syringes (with barrel and piston separate) by boiling only. All instruments not in daily use should be polished, stored dry, and be sterilised before use.

(*j*) *Spatulas.*—For swabbing ward communities, wooden destructible spatulas are convenient. Metal spatulas after use should be boiled for 2 to 5 minutes and then be kept in jars of liquor boracis et formaldehydi. They should be well rinsed before use.

(*k*) *Nose and ear specula* should be boiled for 2 to 5 minutes after every use, stored dry, and re-sterilised before use.

(*l*) *Chest-piece of stethoscope.*—If individual stethoscopes for isolation patients are not provided, the chest-piece of the stethoscope used should be rubbed over with liquor chloroxylenolis after contact with each patient.

(*m*) *Faeces, vomit and urine.*—If from patients with enteric fever, dysentery, food-poisoning or tuberculosis, faeces and vomit should be well covered with diluted " black fluid "; and urine should be poured into a covered receptacle containing diluted " black fluid." The specimens should be left in contact with the disinfectant solution for as long as possible up to four hours, before being sluiced away.

(*n*) *Bedpans, chambers and urinals.*—These, together with their lids, covers cloths, etc., should be disinfected after every use. Bedpans, etc., of all maternity patients must be disinfected by heat after every use; those of other patients should also preferably be disinfected by heat. A copper may usefully be improvised to this end. Where heat disinfection is impracticable, bedpans, etc., should be immersed in diluted " black fluid " in large galvanised iron or enamel baths or bins, reserved for the purpose. They should be kept in the disinfectant for so long as possible between each use, and be rinsed before being employed again.

(*o*) *Sputum and sputum mugs.*—Sputum should be poured into a receptacle containing diluted " black fluid," be left in contact with it for not less than two hours, and then be sluiced away. Mugs should be boiled for 2 to 5 minutes. When dealing with tuberculous sputum, particular care should be taken. If special sterilisers are not provided, sputum and mug should be placed in the steam disinfector and disinfected at 15 lbs. for 20 minutes. Sputum can then be sluiced away and mugs cleaned without risk.

(*p*) *Disposal of refuse.*—Food remnants from staff and patients should be used for pig swill. They should be discarded into covered bins and taken to a central station for boiling down. Empty bins should be washed out with water, preferably hot, sprinkled with chlorinated lime and then rinsed well before being returned to the ward.

(*q*) *Hands.*—Gross contamination of the hands may occur from excreta, sputum, vomit, etc. If so, the hands must be immersed for 2 minutes in liquor chloroxylenolis (1 in 30).[51] Alternatively, stabilised hypochlorite solution (e.g. " Chloros," which contains 12 per cent active hypochlorite) diluted to 1 per cent with tap water, or CTAB[52] (see (*e*) above), may be used. The hands should then be washed in soapy water, rinsed and dried well.

(*r*) *Articles falling on to the floor.*—These must be regarded as grossly contaminated, since floor dust has a high content of pathogenic bacteria. They should be disinfected, preferably by heat, before further use. If this is impracticable, they should be washed in hot, soapy water.

(*s*) *Dusters.*—These should be boiled for 5 minutes after use.

(*t*) *Brooms.*—These should be rinsed daily in a pail containing diluted " black " or " white " fluid.

(*u*) *Floors.*—For local pollution, diluted " white " fluid should be applied.

(*v*) *Sinks and drains.*—Thorough flushing is important. Chlorinated lime is a cheap and efficient disinfectant for sinks and drains. It must be made up freshly. Washing soda, 1 oz. to 1 qt. water, is useful for cleansing glazed earthenware sinks, etc.

3. Terminal Disinfection

After a patient is discharged or transferred, the articles he has used should be treated as indicated below:—

(*a*) *Washed with hot soapy water containing "white fluid":*—Bed, locker and drawers; chair; bed-table; walls and floor of cell or of bed area in open ward.

(*b*) *Washed with hot soapy water containing lysol* 1 *in* 80, *and then rinsed:*—Rubber articles, e.g. hot-water bottles, rubber and mackintosh sheet, air cushion; chart-board; pencil.

(*c*) *Boiled for* 2 *to* 5 *minutes in water:*—Tooth-mug; metal comb; bowls; instruments; thermometer vial; metal toys; medicine glasses; face flannel. Soap remnants should be boiled down with water and later used as hair shampoo.

(*d*) *Disinfected in hospital steam disinfector:*—Mattress; pillows; blankets, including bath blankets. Successful use of the steam disinfector depends upon its skilful operation. Disinfection may not occur, however efficient the apparatus, unless adequate attention is paid to type of material, details of loading, etc. To avoid deterioration of bedding, woollen articles, etc., undergoing repeated disinfection, a pressure of 5 lbs. for 30 minutes should not be exceeded, and special care should be taken in the drying and airing processes.

Where steam disinfection is impracticable, mattresses should have washable cotton covers and these, together with all the patient's blankets, should be sent to the laundry. Hanging mattresses, bedding, etc., out of doors should not be relied on for disinfection.

(*e*) *Washed by laundry* (*after previous disinfection, if required*):—Sheets, pillowslips, counterpane, bedjackets, hot-water bottle covers, towels, etc.

(*f*) *Soaked for* 1 *hour in lysol* 1 *in* 80:—Thermometer, non-metal combs (after washing in hot soapy water), and other articles which will not stand heat.

(*g*) *Incinerated:*—Toothbrush (the only safe alternative would be autoclaving, which spoils even good quality toothbrushes); powder, oil and ointment from back-trays (to avoid unnecessary waste, these should be put out sparingly); magazines and papers (burning of paper is permissible if there is risk of infection being spread). Other articles of small value and still procurable may be incinerated, but if their salvage is deemed necessary, hygienic measures to this end should be devised by the hospital bacteriologist.

APPENDIX B

RULES FOR ISOLATION NURSING IN CELL OR OPEN WARD

These rules comprise the technique known variously as isolation nursing, (see p. 12), bed-isolation nursing, barrier nursing and aseptic nursing[53, 54, 55]. They are intended merely as a general guide, for a hospital may find that its own scheme of rules differs in some particulars from that given here. Every hospital is advised to check over its own rules; if they are satisfactory, there is no need to confuse the staff by making alterations in established practice. The rules adopted must be followed by *all* members of the staff, including doctors, students, masseuses, etc. Otherwise it is discouraging to the nurses, and may nullify the results of their arduous work.

(*a*) Windows and ventilators should be open as much as possible, day and night, winter and summer.

(*b*) Doors of cells should be kept closed whenever possible. Swing doors should be opened with foot or elbow. Handles of ordinary lock doors should be manipulated by hand. The outside handle may be regarded as clean and the inside handle as contaminated.

(*c*) The head of a bed should be 18 inches from the wall. The patient should not touch wall or locker.

(*d*) Each patient should, as far as wartime supplies allow, have his own thermometer, pulse-glass and pencil for charting.

(*e*) The patient's papers and their holder should not be removed from the bed. All charting should be done with a pencil attached to the board.

(*f*) Nurses should work bare-armed.

(*g*) If by any chance a nurse's apron or dress becomes soiled by discharge, it should be changed at once.

(*h*) Each new patient should be received by a nurse wearing a fresh gown, which may afterwards be the nurse's gown for that patient. The blanket from the admitting room may be used as the patient's bath blanket, if not soiled, and may be kept in his locker.

(*i*) Two gowns, one for nurse and one for doctor, should be hung beside each isolation patient. Where possible, a third gown should be reserved for the ward-maid. Gowns are worn to protect the clothing of staff from contamination by the patient; the outside of the gowns is therefore to be regarded as contaminated and the inside as clean. Gowns should be carefully removed and hung on a stand or peg, so as to prevent contamination of the clean inside by the contaminated outside. The word "INSIDE" embroidered in red on the inside neckband of a gown serves as a useful reminder.

(*j*) Before a nurse attends to the patient, e.g. gives a meal, changes a napkin, hands a bedpan—or before the doctor makes an examination—she or he should don the gown reserved for that patient and wash the hands well in soap and water.

(*k*) After attending to the patient, the nurse or doctor should doff the gown, place it carefully on stand or peg, and again wash the hands.

(*l*) The hands of the nurse or doctor should be washed immediately after touching the patient, his bed, papers, thermometer or any other article used in his case, or any article in general use which has not been sterilised. After carrying used crockery, etc., to the kitchen or after dealing with excreta, bedpans, etc., the nurse should wash her hands.

(*m*) Instruments, such as ear syringes, specula, etc., should be boiled after each use. In some hospitals an individual stethoscope is provided for each isolation patient. Failing this, the chest end of the stethoscope used should be rubbed over with liquor chloroxylenolis after contact with each patient.

(*n*) Crockery, mugs, cutlery, etc., should be washed well with hot soapy water after each use, and then be boiled for 5 minutes.

(*o*) Bedpans, chambers and urinals (after disinfection of excreta, if necessary) should be well cleansed in the sluice room. Great care should be taken to avoid splashing. Articles should then be disinfected by heat, if possible; otherwise by immersion in disinfectant (see Appendix A).

(*p*) Patients on isolation nursing should not be visited by convalescent patients.

(*q*) So far as wartime supplies permit, the following individual equipment should be provided for each isolation patient: bed, bed-linen, blankets, chair, locker, bed-table, one or two bath-blankets, mackintosh sheet, dressing mackintosh, head-cape, soap, soap-dish, face-flannel, towels, washing bowl, tooth-mug, tooth-brush, tooth-paste, metal hair-comb, tooth-comb, bib, thermometer and vial, charts, chart-board with pencil attached, two or three lotion bowls, gauze and cotton-wool, pulse-glass, back-tray with oil, powder and ointment. For infants, a special infant bath, and a napkin disposal bin, should be provided.

APPENDIX C

SPECIAL PRECAUTIONS FOR MATERNITY UNITS

As stated in the introduction (p. 4), the general principles for the control of cross infection in hospital wards should be applied also to special hospitals such as maternity units.

1. From the point of view of those working in maternity homes and hospitals, some of the subjects referred to earlier in this Memorandum to which special importance is attached may be enumerated, in order of mention, as follows:—

Haemolytic streptococcal cross infections .. .. See pp. 6, 19

Thrush in infants .. .. See p. 6
Gastro-enteritis of infants .. .. ,, pp. 6, 21
Epidemic diarrhœa of the newborn .. .. ,, pp. 6, 22
"Pemphigus" of the newborn .. .. ,, p. 7
Visiting in maternity wards .. .. ,, p. 13
Hand-washing .. .. ,, p. 15
Disinfection of linen and napkins .. .. ,, pp. 15, 24
Breast-feeding .. .. ,, p. 16
Milk .. .. ,, p. 16
Bottle-feeds .. .. ,, p. 16
Milk kitchens .. .. ,, p. 16
Face-masks .. .. ,, p. 17
Rules for isolation nursing .. .. ,, p. 26

2. In addition, special mention should be made of the need for adopting a strictly aseptic technique in the perineal toilet of lying-in patients. The precautions outlined in Appendix D for the dressing of wounds should be followed as far as possible. The technique would, however, have to be adapted on the following lines:—

In lying-in wards, the Dresser who undertakes the toilet, prepares the dressing tray for each patient and remains clean throughout. The Assistant prepares the patient for the toilet, gives the bedpan and removes soiled pads and swabs. Otherwise the same aseptic precautions should be observed.

3. Extract from "The Control of Puerperal Sepsis," Memo $\frac{226}{\text{Med.}}$, Ministry of Health, 1939. H.M.S.O.

"The general measures which are of importance in the prevention of puerperal sepsis have been discussed in detail by Colebrook.

" The problem as it affects the conduct of maternity homes and domiciliary practice is how to apply preventive methods without interfering unnecessarily with the smooth working of the services. How far, for example, is it practicable and necessary to exclude nose and throat carriers of haemolytic streptococci from the environment of the parturient woman? To search for and exclude all carriers of haemolytic streptococci is not practicable. Nevertheless, there is a sufficient volume of evidence now available to indicate how the risks to the parturient woman may be minimised by the intelligent use of bacteriological methods.

" The question has to be considered from two standpoints: (*a*) in the absence of puerperal pyrexia; (*b*) on the occurrence of puerperal pyrexia.

" (*a*) In the absence of puerperal pyrexia, swabbing of the midwife in attendance should not be undertaken unless she shows signs of an acute or chronic inflammatory condition of the tonsils, pharynx, nose or middle ear. Every midwife should be instructed to report any symptom of such a condition at once, whereupon she must be suspended from duty and swabs must be taken for bacteriological examination. In the event of a positive swab being obtained, there may be some doubt whether the haemolytic streptococci found are responsible for the clinical condition or are merely temporary invaders. Though the distinction is important, as experience shows that where they are actually producing inflammatory conditions the streptococci are more dangerous, there is no known bacteriological method of making this distinction; the number of colonies is no certain criterion of the presence or absence of an infective process. It is advisable, therefore, to suspend every midwife who has reported naso-pharyngeal symptoms and has been found to be a carrier of haemolytic streptococci; if it is found by the laboratory that the streptococci belong to Group A, she must not resume duty until she has recovered completely and three negative swabs at daily intervals have been obtained.

" To prevent future hardship, candidates for training as pupil midwives should be examined clinically and those suffering from a chronic infection of

the tonsils or sinuses with haemolytic streptococci should be advised that a persistent disability of this character is likely to preclude them from engaging in the practice of midwifery.

"(*b*) On the occurrence of puerperal pyrexia, steps should be taken at once to ascertain the cause of the rise of temperature, and until the existence of infection of the genital passages with haemolytic streptococci has been excluded, the attendant contacts must not conduct a labour or nurse any other puerperal woman. Recent experience has shown clearly that whenever there is a streptococcal infection of the body of the uterus the organisms will be present in the vagina. If the infection is limited to the vagina or perineum (though it very rarely is), there is nothing gained, but the contrary, by passing a swab into the cervix uteri. A vaginal swab should therefore be taken in every case of puerperal pyrexia, unless the practitioner can be quite certain that the fever is not due to infection of the genital tract. This involves the examination of a large number of swabs—many of which will not yield haemolytic streptococci. In some districts this may necessitate the extension of the bacteriological services. Nevertheless, the bacteriological examination of a vaginal swab in puerperal pyrexia is a precaution which can rarely be omitted with safety. If the vaginal swab yields haemolytic streptococci—the report should be available in 24 hours—an attempt should be made to ascertain whether any of the attendants was the possible source of infection. To this end, swabs should be taken from the nose and throat and from any skin lesion of the doctor or midwife who was in attendance on the patient during her confinement or subsequently. If, however, streptococcal infection of the patient is suspected from the outset, swabs from the attendants should be sent for examination at the same time as is the patient's vaginal swab. The bacteriological examination of contacts will as a rule be limited to those persons who might in the course of their duties carry infection to other parturient women, i.e. primarily doctors and midwives.

"Any attendants found to be harbouring haemolytic streptococci must cease to attend labours or to nurse other puerperal women until three negative swabs taken at daily intervals from both nose and throat have been obtained and clinical signs, if any, have disappeared. This rule is subject to certain exceptions depending on the results of further bacteriological investigation."

Haemolytic streptococci of Group A Lancefield are the most likely to cause puerperal infection, but those of Groups B, C and G may also be a source of danger.

APPENDIX D

RULES FOR A WARD DRESSING TEAM

The following short list of rules has been approved by the War Wounds Committee of the Medical Research Council, and by the Committee of London Sector Pathologists, and is based on M.R.C. War Memorandum No. 6 [21], to which reference should be made for further details.

The rules must be followed for infected as well as clean wounds.

Dusting, sweeping, bedmaking, and unnecessary traffic in the ward are to cease at least one hour before wound dressing.

Windows and doors are to be kept shut during dressing.

One wound only is to be uncovered at a time.

Two persons are needed:

1. A Dresser, who takes off bandages and dressings and attends to the toilet of the wounds.

2. An Assistant, whose sole duty is to look after the trolley and pass clean things to the Dresser.

At the start of the round of dressings, both put on masks and gowns; the Assistant washes his hands in soap and water and dries them on a clean towel.

The Dresser turns back the bedclothes gently without raising dust; he arranges the patient in position, takes off the bandages and outer dressings,

and places them in the Salvage or Destructor bin, according to their condition. He then washes and dries his hands. From this point, all the work is done with sterile forceps. The hands never come in contact with the wound or skin around it, soiled or clean dressings, sterile lotions, etc. The Dresser, using forceps, removes the inner dressings and drops the soiled materials into the Destructor bin. If desired, a sterile towel, passed to the Dresser by the Assistant, is laid near the wound as a convenient rest for dressings and instruments. The Assistant opens the dressings package or, if large drums are used, places the necessary dressing material in a sterile dish. Using two pairs of forceps, the Dresser then cleans the skin around the wound; performs the necessary toilet (removal of stitches, drains or packing; irrigation, etc.) and covers the wound with a sterile dressing. Great care must be taken to fix the bandage so that it cannot slip.

All sterile material needed by the Dresser is passed to him by the Assistant with forceps which never touch anything that is not sterile. Particular care must be taken that the forceps of the Dresser *never* touch those of the Assistant.

The Dresser then discards his forceps for re-sterilisation and applies the outer dressing and bandages; he then washes and dries his hands before proceeding to the next case.

For complicated dressings, an extra assistant may be required. He must regard himself as contaminated, and wash his hands thoroughly before proceeding to other duties.

Re-sterilisation of instruments after use consists of scrubbing them with soap and water and then boiling them for 5 minutes (in 2 per cent sodium carbonate solution).

APPENDIX E

APPLICATION OF SPINDLE OIL TO FLOORS

Spindle oil is a crude petroleum oil extensively used in the cotton industry as a lubricant. (Specifications: cloud test at 0° C. clear; sp.gr., 0·886; kinematic viscosity 53·21 centistokes at 20° C., 22·3 centistokes at 37·8° C.; Redwood viscosity 201 sec. at 70° F., 95 sec. at 100° F., 52 sec. at 140° F.; flash point (Pensky-Martin) closed 178° C., open 187° C.) It is obtainable from any large dealers in oil. The amount required for an application is about 1 gallon per 800–1000 sq. ft. Its cost is low and is more than offset by economy in floor polishes.[45]

Spindle oil should be applied only to linoleum (glossy or cork-inlaid) or to wood floors. It soaks too rapidly into concrete floors to remain effective. It damages rubber and certain composition floors. Oiled floors are not unpleasant in appearance, and are odourless. Slipperiness of the floor may cause inconvenience for a few hours after oiling, but this rapidly passes off. Patients on crutches find the surface preferable to that of a polished floor.

Before oiling, a floor should be scrubbed thoroughly with soap and warm water to remove old polish. It should be left to dry for 16 to 24 hours. The oil should be applied *sparingly*, at the time of least ward traffic. The staff should be warned of possible slipperiness, and children should be kept in bed for a few hours after the oiling. Large mops on handles should be used, in order to cover the area quickly and to protect the hands from oil. The effect of oiling lasts for increasing periods after each treatment. Applications should therefore be made two weeks and five weeks after the first oiling, and subsequently at seven-week intervals. If the floor must be washed in the meantime, it should be re-oiled when dry. Oiled floors should be dry-swept. They should not be polished.

APPENDIX F

COURSE OF PRACTICAL BACTERIOLOGY FOR NURSES

Two series of recent articles in the nursing journals provide useful reading material for nurses taking this course. One deals with the classification of bacteria,[56] and the other with medical bacteriology for nurses.[57]

Demonstration

(*a*) Convey the idea of the size of bacteria, e.g. the haemolytic streptococcus (*Str. pyogenes*) has an average diameter of 0·75 μ (1 μ = 1/25000 inch), so 33000 cocci side by side would measure 1 inch. Show the class 1 inch on a ruler—or a halfpenny, which is 1 inch in diameter.

(*b*) Show a plate culture of an organism (e.g. *Str. pyogenes* or *Bact. coli*) with discrete colonies grown for 24 hours at 37° C. on blood agar. Explain that one colony consists of a mass of individual bacteria (some dead, some dying, many alive) totalling from 5 million to 100 million or more (according to the conditions of growth and the organisms used).

(*c*) Show a broth culture of *Bact. coli* (incubated for 24 hours at 37° C.). An actively growing strain subdivides about every 20 minutes, and a 24-hour culture will contain 1000 million to 2000 million bacteria per c.c.

(*d*) Show a hanging drop of motile *Bact. coli*, and explain why some organisms are motile and why others are non-motile. Explain that the microscope with 1/12" objective magnifies the individual organisms about 1000 times.

(*e*) Show a stained smear of *Bact. coli* under the microscope—bacteria are normally colourless and need to be stained with dyes (blue and red). All organisms stain with the blue stain but some lose their colour if treated with alcohol; these stain with the red dye. The others retain the blue stain in spite of treatment with alcohol, and remain blue. The method of staining is known as Gram's method; the blue-staining organisms are Gram-positive and the red-staining organisms are Gram-negative.

(*f*) Show cultures of Staphylococcus, Streptococcus, Meningococcus, Pneumococcus, and of Tubercle, Diphtheria, Typhoid, Paratyphoid and Colon bacilli, and explain their habitats, methods of spread and relation to disease.

(*g*) Show stained smears of these organisms under the microscope and explain the degree of magnification, and the reasons for staining.

Practical Work

(*a*) Demonstrate, and then let the nurses practice carefully, the simple technique of transferring an inoculum from a broth culture to a tube of sterile broth. Incubate tubes and show resulting growth.

(*b*) Expose blood agar plates to the air of a ward (e.g. scarlet fever or E.N.T.) for 2 to 3 hours during a busy period (7–10 a.m.) and during a quiet period (12 midnight to 3 a.m.).

(*c*) Demonstrate the proper method of taking nasal, throat and naso-pharyngeal swabs (good light, inspection, tongue depressor, decide what part of the fauces to swab, avoid touching the lips, teeth, tongue and buccal mucous membrane).

(*d*) Let nurses pair off and take swabs from each other (nasal, throat and naso-pharyngeal); demonstrate how plates are inoculated, and show them on the following day the growths from their own swabs on blood agar plates.

(*e*) Moisten a swab in saline, rub it over the fingers and inoculate on to the plate. Repeat after washing the hands in soap and water without vigorous scrubbing.

(*f*) Inoculate blood agar plates with swabs from infected wounds, empyema or other pus, abscess, whitlow, impetigo, etc., and demonstrate the resulting growth. Explain that tuberculosis is diagnosed by microscopic examination of stained smears; by culture or by animal inoculation.

(*g*) Infect a small piece of blanket (6 inches square) with a non-pathogenic organism, dry, and then flick blanket over a blood agar plate (to imitate bed-making) and show the plate culture after incubation.

(*h*) Collect some dust from a ward floor (e.g. scarlet fever or E.N.T. ward), suspend in a small amount of saline, shake up well and inoculate on to (*a*) a blood agar plate, (*b*) a blood agar plate containing 1/500,000 gentian violet, which inhibits the growth of staphylococcus and indirectly encourages growth of haemolytic streptococcus.

(*i*) Spread some floor dust on a table, put an open blood agar plate in the centre, disturb the dust with a duster, leave for 5 minutes and incubate the plate (a control plate can be left exposed on the table for 5 minutes before disturbing the dust).

(*j*) Infect some instruments (artery forceps, etc.) with pus. When dry, rub the infected part with a moist sterile swab and inoculate the swab on to a blood agar plate.

Boil the infected instruments in water for 2 minutes and when cool, swab the formerly infected part again and inoculate the swab on to a blood agar plate.

Hand the sterile instruments round and let them be thoroughly handled, and again take a swab of the instruments and inoculate a blood agar plate.

This teaches that everything handled becomes potentially infective.

(*k*) Inoculate a sample of fæces on to MacConkey agar and blood agar, to demonstrate the flora. Draw moral from cases of typhoid and dysentery, and stress the necessity of washing hands *always* after going to the lavatory, as fingers are *always* soiled and infection may thus be conveyed to clothes, food and drink.

(*l*) Take swabs from scum on the sides of a bath after use by a patient, and draw the lesson of failure to clean the bath properly between one patient and the next.

(*m*) Discuss the heat-treatment of milk by pasteurisation and by boiling. Point out the dangers of giving raw, or imperfectly pasteurised, milk to infants and children (see p. 16). Mention the infections of which milk may be the vehicle—tuberculosis; intestinal infections such as enteric fever, salmonella food-poisoning and dysentery; streptococcal infections; undulant fever; diphtheria.

Take a sample of milk, artificially contaminate it with *Bact. coli* to simulate raw milk, and plate a loopful on to blood agar. Then divide the sample into two portions by pouring a few c.c. into each of two sterile plugged test-tubes. Pasteurise one portion in a mug or water-bath at 63–65° C. for 30 minutes; boil the other portion for 2 minutes. Cool both portions rapidly and plate a loopful from each on to blood agar. Show the three plates after incubation.

APPENDIX G

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